

CAREER: Effects of Pressure and Magnetic Field in Strongly-Correlated-Electron-Systems with Non-Collinear Magnetism

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In 2003, our research focused on identifying potential trends in the magnetic properties for a variety of strongly-correlated-electron systems under hydrostatic pressure. In the case of uranium compounds, trends seem to emerge when comparing experimental data with tight-binding calculations (see tables of exemplary UTX compounds). More localized uranium antiferromagnets (= smaller V_{total}) exhibit:

- larger critical pressure p_c for suppression of the antiferromagnetic ground state
 - smaller (or even positive) shifts of the ordering temperature dT_N/dp , and
- positive (or small negative) shifts for the field-induced metamagnetic transition field dB_c/dp .

Compound	T_N (K)	dT_N/dp (K/kbar)	dB_c/dp (T/kbar)	p_c (kbar)
UIrGe	14.5	-0.34	-0.06	48
UNiGe	41.5*	< -0.10	0.24	>300
UNiAl	17.1	-0.185	-0.062**	105
UNiGa	34.1*	-0.11	0.04	>300
UPdSn	40/25***	0.19	-0.06***	70***
UCoAl	20****	-	0.27****	24

Compound	V_{ff} (meV)	V_{fp} (meV)	V_{fd} (meV)	V_{total} (eV)
UIrGe	128.4	615.8	749.1	0.978
UNiGe	147.1	287.4	749.3	0.816
UNiAl	166.0	527.1	828.0	0.995
UNiGa	165.8	458.7	778.1	0.918
UPdSn	101.8	512.9	436.8	0.688
UCoAl	172.7	536.4	872.1	1.04

*other transitions occur at slightly higher temperatures

**derived from extrapolation of pressures below 1 kbar

***UPdSn exhibits two antiferromagnetic transitions (values for T_{N2})

****UCoAl forms a metamagnetic ground state

V_{ff} : direct 5f-5f overlap

V_{fp} : hybridization between the uranium 5f and the ligand p-states

V_{fd} : hybridization between the uranium 5f and the ligand d-states

V_{total} : total hybridization

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- In 2003, this NSF-CAREER grant supported 5 graduate students (A. Alsmadi, A. Buin, S. Chang, S. El-Khatib and R. Rajaram) and 1 undergraduate student (J. Schaub).
- During our weekly group meetings, the students acquired all necessary expertise for doing research on correlated-electron systems using a variety of experimental and theoretical techniques. This included the study of bulk magnetic properties (such as, magnetization, magnetoresistance, specific heat, magnetostriction), neutron diffraction data (including Rietveld refinement of magnetic diffraction data), inelastic neutron scattering results (crystal fields, spin waves) and modeling of magnetic properties (tight-binding calculations, LSDF).
- Sami El-Khatib attended a *Workshop on Magnetism* at the UC, Santa Cruz.
- Sung Chang defended his PhD thesis on *Magnetic transitions in some strongly-correlated-electron systems* and Ramya Rajaram defended a masters thesis on *Crystal field in Uranium Dioxide*.
- The PI and his students have given a number of invited and contributed seminars, colloquia and talks at international meetings and workshops.
- **In 2003, Heinz Nakotte has been awarded the NMSU University Research Council's Award for Exceptional Achievements in Creative Scholarly Activity.**